PATENT ABSTRACTS OF JAPAN

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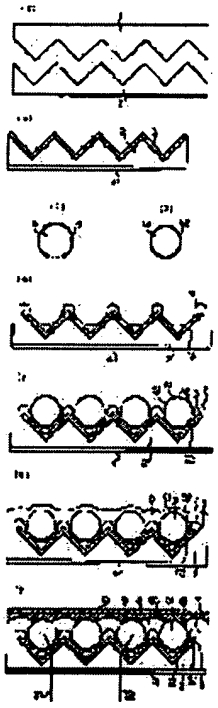
(54) SPHERICAL OR ROD-SHAPED CRYSTAL SOLAR CELL AND ITS MANUFACTURE

(57)Abstract:
PROBLEM TO BE SOLVED: To freely prescribe the dimensions of a rod-shaped semiconductor and the arrangement condition/density onto a substrate, by arranging a second conductive layer in electrical contact at one portion of a semiconductor substrate at a part that differs from one portion of the spherical or rod-shaped semiconductor crystal in contact with a first conductive layer.
SOLUTION: A transparent electrode 3 is glued to the inverse-pyramid-shaped structure of a first substrate 1 as a first conductive layer, and a reflection prevention film 4 is glued to the other surface at the opposite side. Then, a spin-on glass 7 is applied to the recessed and projecting surface of a first substrate 2, and a number of spherical Si consisting of an n-type layer 52 and a p-type part 51 are arranged. Then, one portion of the n-type layer 52 of each spherical Si and the transparent electrode 3 are electrically brought into contact with each other, a spin-on glass film 8 is applied and one portion 63 of a p-type exposure part 61 that is a thin part is exposed by etching, and a p electrode 9 and a high-reflection film 10 are glued as a second conductive layer on it.



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CLAIMS

[Claim(s)]
[Claim 1] It has the structure arranged on the first substrate in which two or more spherical or rod-like semiconducting crystals have periodic concavo-convex structure. The first conductive layer is arranged on the periodic concavo-convex structure constituted by this first substrate. Some semiconducting crystals of the shape of spherical or a rod come to contact electrically to this first conductive layer. it is characterized by the thing in contact with this first conductive layer which it comes to arrange spherical or the second conductive layer which these some semiconducting crystals of a different part from some rod-like semiconducting crystals contacted electrically -- spherical or a cylindrical crystal solar battery.
[Claim 2] being according to claim 1 -- spherical or a cylindrical crystal solar battery -- setting -- this -- the semiconducting crystal of the shape of spherical or a rod -- this -- it is characterized by making it come densely to arrange in the first substrate side -- spherical or a cylindrical crystal solar battery.
[Claim 3] being according to claim 1 -- spherical or a cylindrical crystal solar battery -- setting -- this -- the semiconducting crystal of the shape of spherical or a rod -- this -- dissociate mutually in the first substrate side, and it is made to arrange, and is characterized by making it make a part of incident light penetrate -- spherical or a cylindrical crystal solar battery.
[Claim 4] being according to claim 1 -- in spherical or a cylindrical crystal solar battery, the semiconducting crystal of the shape of spherical or a rod is made into a unit, within said unit, each semiconducting crystal approaches or contacts and said semiconducting crystal is characterized by said two or more things [dissociating mutually and coming to be arranged] between said units -- spherical or a cylindrical crystal solar battery.
[Claim 5] spherical or the method of manufacturing a cylindrical crystal solar battery -- setting -- this -- it is characterized by to include the second process which gives spherical or irregularity structure periodic to the first process which produces a rod-like semiconducting crystal, and the matter which constitutes this first substrate, and the third process made to arrange uniformly by making said crevice on the first substrate drop said semiconducting crystal -- the manufacture approach of spherical or a cylindrical crystal solar battery.
[Claim 6] in the approach of manufacturing a cylindrical crystal solar battery, in case this first substrate is manufactured, it is characterized by the thing [including spherical, or the fourth process which forms the mold which has periodic concavo-convex predetermined structure beforehand and the fifth process which forms this first substrate by imprinting the concavo-convex structure which this mold has] according to claim 5 -- the manufacture approach of spherical or a cylindrical crystal solar battery.
[Claim 7] in the approach of manufacturing a cylindrical crystal solar battery, it is characterized by the thing [that spherical or the part which constitutes the irregularity in this mold consists of silicon] according to claim 6 -- the manufacture approach of spherical or a cylindrical crystal solar battery.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is the thing about spherical or the solar battery which uses a rod-like semiconducting crystal as a main component by which adhesion support was carried out on the substrate.
[0002]
[Description of the Prior Art] Expectation is attracted as a way stage supporting the energy need in the 21st century from the description that the solar battery which uses silicon (it is hereafter described as Si) as typical material has few elements which pollute an environment compared with other power generation means in the process of its manufacture and use.
[0003] The comparatively efficient solar battery with which practical use is widely presented from the former Since the wafer (typically 350-micrometer thickness) cut down from the bulk crystal of the single crystal formed by melting raising etc. thru/or Polycrystal Si is finally comparatively used as start material through the high grade chemically-modified [various] degree from the metal class Si of a low price, the material wafer itself -- expensive -- therefore, a solar battery element -- the part -- expensive -- not becoming -- it did not obtain but had become the hindrance of spread.
[0004] On the other hand, it is Texas Instruments in order to achieve low-pricing of a solar battery element. The shrine produced the spherical crystal grain child with a diameter of a little less than 1mm. This particle was embedded at the aluminum foil with which the hole opened, and the solar battery was produced through the component chemically-modified [various] degree (refer to JP,6-13633,A; here, it is called the aluminum method).
[0005] The configuration of this aluminum method is shown in drawing 5 . It is insulating resin prepared between the aluminum foil 122 with which the aluminum foil with which 121 in drawing constitutes a p-type silicon ball, and 122 constitutes a negative electrode, and 123 constitute n mold diffusion layer, and 124 constitutes the above-mentioned negative electrode, and the aluminum foil 125 which constitutes a positive electrode. And he forms a hole in aluminum foil 122, and is trying to arrange some p-type silicon balls 121 there. Since this approach was using the cheap material as the start ingredient, the punching process to the aluminum foil of what a solar battery cheap as a result may consist of had the complicated process to which precision embeds the low and spherical p-type silicon ball 121 in a hole, and a high speed and a lot of manufacture had the fault of being unsuitable.
[0006] Moreover, some which have arranged spherical Si were between each mesh on the base material knit in the shape of a mesh as another attempt (refer to JP,9-162434,A; here, it is called a mesh method).
[0007] The configuration of this mesh method is shown in drawing 6 (a) and (b). (a) the positive electrode with which a granular Si cel and 202 consist of glass/aluminum/Ag among drawing in 201 -- a conductor and the negative electrode with which 203 consists of glass/Ag -- a conductor and the insulating support which 204 becomes from glass -- it is -- insulating support 204, forward, and a negative electrode -- a conductor 202,203 is knit in the shape of a mesh, and the granular Si cel is arranged between meshes. By this approach, in addition to cost starting production of a reticulated base material, the problem was in the homogeneity of the magnitude of a mesh, and when offering the solar battery of a low price and high-reliability, there was a problem.
[0008] Moreover, drawing 6 (b) shows cross-section structure. p mold granular silicon with which the inside 231 and 232 of drawing constitutes a granular Si cel in the (a) Fig., n mold diffusion layer, and 233 -- the (a) Fig. -- setting -- a negative electrode -- the negative electrode equivalent to a conductor 203 -- a conductor and 234 -- the (a) Fig. -- setting -- a positive electrode -- the positive electrode equivalent to a conductor 202 -- as for a conductor and 235, p mold alloying field and 236 are closure

resin. and a mesh-like negative electrode -- a conductor 233 and a positive electrode -- although a conductor 234 and the insulating support 204 in the (a) Fig. are minded and he is trying to arrange and support spherical p mold granular silicon 231, there is the above-mentioned trouble.
[0009] The fault common to describing [above] the aluminum method and the mesh method had the problem that it was difficult on each base material (aluminum foil and network) to arrange the shape of a ball tidily in the consistency and array as a design.
[0010]
[Problem(s) to be Solved by the Invention] It is cheap and a base material consists of substrates of high degree of accuracy and high-reliability, and the place which this invention was proposed in view of the above-mentioned thing, and is made into that purpose is spherical or a thing which can also specify freely the dimension of a rod-like semi-conductor, and the arrangement condition and the consistency to a substrate top and which offers that manufacture approach while offering spherical or a cylindrical crystal solar battery.
[0011]
[Means for Solving the Problem] It has the structure arranged on the first substrate in which two or more rod-like semiconducting crystals with this spherical or invention have periodic concavo-convex structure. The first conductive layer is arranged on the periodic concavo-convex structure constituted by this first substrate. Some semiconducting crystals of the shape of spherical or a rod come to contact electrically to this first conductive layer. It considered as the configuration in contact with this first conductive layer by which spherical or the second conductive layer which these some semiconducting crystals of a different part from some rod-like semiconducting crystals contacted electrically has been arranged, and the above-mentioned purpose is attained.
[0012] moreover, spherical [above-mentioned] or an above-mentioned cylindrical crystal solar battery -- setting -- this -- the semiconducting crystal of the shape of spherical or a rod -- this -- it is characterized by making it come densely to arrange in the first substrate side.
[0013] furthermore, spherical [above-mentioned] or an above-mentioned cylindrical crystal solar battery -- setting -- this -- the semiconducting crystal of the shape of spherical or a rod -- this -- dissociate mutually in the first substrate side, and it is made to arrange, and is characterized by making it make a part of incident light penetrate.
[0014] Furthermore, the semiconducting crystal of the shape of spherical or a rod is made into a unit, within said unit, each semiconducting crystal approaches or contacts and said semiconducting crystal is characterized by said two or more things [dissociating mutually and coming to be arranged] between said units again.
[0015] Moreover, it is characterized by the thing which come to contain the second process which gives spherical or irregularity structure periodic to the first process which produces a rod-like semiconducting crystal, and the matter which constitutes this first substrate, and the third process made to arrange uniformly by making said semiconducting crystal drop into said crevice on the first substrate as the manufacture approach and for which spherical or a cylindrical crystal solar battery is manufactured.
[0016] Moreover, in the above-mentioned manufacture approach, in case this first substrate is manufactured, it is characterized by including the fourth process which forms the mold which has periodic concavo-convex predetermined structure beforehand, and the fifth process which forms this first substrate by imprinting the concavo-convex structure which this mold has.
[0017] Furthermore, in the above-mentioned manufacture approach, it is characterized by the part which constitutes the irregularity in this mold consisting of silicon.
[0018]
[Embodiment of the Invention] In short in this invention, the front face has adopted the solar-battery structure which comes to support the semiconducting crystal of the shape of a globular shape and a rod on the so-called substrate of the reverse pyramid configuration of making concave convex. Namely, the structure arranged on the first substrate with periodic concavo-convex structure in two or more spherical or rod-like semiconducting crystals is given. The first conductive layer is arranged on the periodic concavo-convex structure constituted by this first substrate. this first conductive layer -- receiving -- the above -- it is considering as spherical or the configuration which some rod-like semiconducting crystals were contacted electrically and has arranged this first conductive layer and the second conductive layer which contacted, and which contacted spherically electrically to some semiconducting crystals of a different part from some rod-like semiconducting crystals. And it enables it to acquire a desired property by setting up the configuration of concavo-convex structure, an array, and a period suitably.
[0019] That is, if it is periodic irregularity structure, the thing with the dimension of the concavo-convex structure and the dimension which agreed made to arrange easily the semiconducting crystal of the shape of spherical or a rod on this substrate is possible. If the mold made from Si is used especially, by applying

a known photolithography technique, concavo-convex period/dimension can specify arrangement condition and a consistency to a precision easily, and can offer a substrate cheaply and in large quantities by imprinting this mold structure further. By using such a substrate, spherical or the solar battery with which the cylindrical crystal has been arranged by the distribution density of arbitration of the dimension corresponding to the purpose can be offered.

[0020]

[Example 1] Drawing 1 (a) - (h) shows the 1st example of this invention. First, in the (a) Fig., one in drawing is the mold which becomes by Si, and produced the concavo-convex structure of the shape of a reverse pyramid which consisted of Si (111) sides with the known photolithography technique. The potassium hydroxide performed etching. The concavo-convex structure of mold 1 was imprinted by clear glass 2, and made this the first substrate 2.

[0021] Subsequently, as shown in the (b) Fig., in order to use it as one electrode of a solar battery on the reverse pyramid-like structure of this first substrate 2, the transparent electrode 3 was made to adhere as the 1st conductive layer, and the antireflection film 4 was made to adhere to the field (for it to become the plane of incidence of sunlight behind) of ** of the opposite side.

[0022] On the other hand, 1100 degrees C and heat-treatment of 10 hours separated into the layer 6 near the front face containing many impurities, and p form part 5 with few impurities Si crystal into which the metal class Si was spherically processed as a raw material, as shown in the (c) Fig. Diffusion process of n form was performed to p form part 5 of a spherical high grade after etching removal in the layer 6 near the front face, and it was set to spherical Si which consists of a ball with a diameter of 0.5mm which consists of an n form layer 52 and the p form section 51 as shown in the (d) Fig.

[0023] The deer was carried out and spherical Si of a large number prepared in the (d) Fig. was put on what was applied as the sign 7 showed spin-on glass (it is called Following SOG) in the (e) Fig. to the concave convex of the first substrate 2 obtained in the (b) Fig. By adjusting the magnitude of spherical Si and a reverse pyramid configuration the optimal, each spherical Si was easily settled in each pyramid part uniformly.

[0024] Next, the pressure was put on much whole spherical Si, and it was made to stick with the first substrate 2 by heating at about 180 degrees C. SOG7 changed in the process to stick and, finally the part and transparent electrode 3 of the n form layer 52 were contacted electrically.

[0025] Then, while passing through vitrification processing of SOG several 100 degrees C or more, etching processing was performed and the part of n form layer of spherical Si which does not touch SOG7 became the cross-section structure shown in the (f) Fig. The part to which the n form layer 52 was etched into and p form section exposed 61, and 62 are the electric contact parts of the n form layer 52 and a transparent electrode 3.

[0026] If etching of this layer is advanced on this structure after applying the SOG film 8 further as shown in the (g) Fig., a part of p form outcrop 61 63 which is a part with thin thickness among the SOG film 8 will be exposed.

[0027] Besides, as shown in the (h) Fig., the p electrode 9 as the second conductive layer and the high reflective film 10 are made to adhere, and a solar battery is completed. Incidence of the sunlight was carried out like 21 and 22, high optical confinement was realized by compound of effectiveness, such as the so-called texture structure by the antireflection film 4 and the reverse pyramid, and extensive incidence angular aperture by spherical Si, and the efficient solar battery was realized as a result. SOG7 which is filling between Si ball and Si balls had become a mask at the time of etching the conductive layer and electrode of Si semi-conductor like the role of Si oxidization insulator layer in Si integrated circuit (IC), and such a process serves as a technique which matured enough in IC manufacture, and it was able to apply it to securing the insulation of each interglobular space, and coincidence with the same dependability also as this invention.

[0028] By the approach by this invention, even if fluctuation of some is in the magnitude of spherical Si, there is no problem on production, and each ball functions completely as one cell. That the precision of the magnitude of a ball is loose means that the price at the time of spherical Si formation can be kept cheap.

[0029] Moreover, although a transparent electrode 3 and the p electrode 9 are common to each spherical Si and each ball constitutes the solar battery from this example in juxtaposition, it is also possible to combine a ball with a serial and to obtain the high solar battery element of power as a whole by mixing the process which performs processing which divides two electrodes suitably, and constitutes them and connects between a ball and balls suitably.

[0030]

[Example 2] Drawing 2 shows the 2nd example of this invention. Although the profile of the production process of this 2nd example was almost the same as the 1st above-mentioned example, in order to raise

the condensing nature of sunlight, while carrying out periodic convex processing as a sign 41 shows and using sunlight plane of incidence of the first substrate 2 as an antireflection film 41, in order to collect the reflected lights in Si ball effectively, as a sign 11 also showed the high reflector of the opposite side, convex processing was carried out by this example. this example -- this -- since it is made in agreement in the period of the array of a rod-like semiconducting crystal, and the period of convex processing of plane of incidence spherically as shown in drawing, the light reflected as it was effectively condensed by spherical Si and a sign 25 showed contributes similarly effectively the sunlight which carried out incidence as signs 23 and 24 showed to a return generation of electrical energy at spherical Si.

[0031] In addition, p electrode uses the transparent electrode 91. In this example, it is possible by adjusting the curvature of convex processing of an antireflection film 41 the optimal to the thickness of the first substrate 2 to draw incident light 23 and 24 in Si ball effectively. Moreover, in this example, introducing in Si ball effectively again is possible by reflecting again the light which penetrated not only the incident light 23 and 24 but the light or Si interglobular space which once penetrated the inside of Si ball by the high reflective film 11. It is possible by adjusting the curvature of convex processing of the high reflective film 11 the optimal to the thickness of a transparent electrode 91 also in this case to draw the reflected light in Si ball effectively.

[0032] In this example, the light of oblique incidence as shown with signs 23 and 24 is also incorporated by owner ** in Si ball as mentioned above. This means that it can generate electricity effectively also to the incident light toward which not only the neighborhood but every morning and evening inclined in the daytime at the time of the meridian transit of daytime. Furthermore, therefore there are many clouds like a climate climate of Japan, the effective thing is meant also when there are many components of the scattered light compared with direct light.

[0033]

[Example 3] Drawing 3 (a) - (c) shows the 3rd example of this invention. In the case of this example, it is used in order for the second substrate 20 which has concavo-convex structure not to have an electrode etc. but to make spherical Si arrange like said 1st example. In addition, the process to drawing 3 (a) is fundamentally advanced like the aforementioned explanation to (a) - (f) in drawing 1 except for the formation process of the transparent electrode 3 shown in drawing 1 . However, the measure in which the n form layer 52 and the second substrate 20 of spherical Si are not stuck firmly unlike the 1st example is taken. This is possible by applying suitable exfoliation material beforehand, for example.

[0034] Moreover, since the process to drawing 3 (b) is the same as the process to drawing 1 (h), the same sign shows the same member and detailed explanation is omitted. Then, the second substrate 20 exfoliates and a solar battery as a transparence n electrode and an antireflection film (it omits by a diagram) given and subsequently to a part of n form layer 52 shown in the (c) Fig. completes it. In the solar battery of this example, the condensing nature of sunlight 26 and 27 is high by the own lens effectiveness of Si spherical surface. In addition, in each above-mentioned example, although the thing spherical as a semiconducting crystal was explained, a cross section may use the rod-like thing which makes a round shape.

[0035]

[Example 4] Drawing 4 shows the 4th example of this invention. (a) Drawing adjusted the period of the concavo-convex structure of the third substrate 30, and the dimension so that it might become the maximum nectar restoration about the array of a ball or a rod. In making a ball or a rod arrange, concave heights are turned for the third substrate 30 and the second substrate (not shown in drawing) with the same periodic structure down from the upper part part of the (a) Fig. this -- two or more spherical or rod-like semiconducting crystals were able to be made to arrange easily the neither more nor less on the third substrate 30 by putting in the shape of sandwiches like the second substrate / ball, or the third rod / this substrate, and pushing lightly

[0036] What is necessary is just to use the third and second substrates with the concavo-convex structure of the dimension doubled with the diameter of the ball to produce, in order to realize the maximum nectar restoration. If it is made the configuration of the maximum nectar restoration as shown by drawing 4 (a), since there will be no light which penetrates between Si ball or rods, it is possible to catch sunlight more effectively and high photoelectric conversion efficiency can be attained.

[0037] Contrary to the (a) Fig., the thing of drawing 4 (b) opens clearance and arranges a ball or a rod to a non-dense. 92 are a transparent electrode and a protective coat with transparent 12 among drawing. Although a part is caught by spherical or the cylindrical semi-conductor among the sunlight which carries out incidence as signs 21 and 22 show, a part is penetrated like 28 and 29. That is, the solar battery of a see-through form so-called translucent type can be made as a whole. The rate of the transmitted light to all incident light can be set as arbitration by adjusting the arrangement consistency of a ball or a rod suitably.

[0038] (a) and (b) are the examples which performed a different array, and the thing of drawing 4 (c) consists of forms which a part with the dense array of Si ball or a rod and a **** part compound. namely, plurality -- said -- the semiconducting crystal of the shape of spherical or a rod was made into the unit, and within said unit, each semiconducting crystal approaches or contacts, and between said units, said semiconducting crystal dissociated mutually and has arranged. In addition, in this drawing, the configuration of the part of the substrate which presented periodic structure is omitted, and it cannot be overemphasized that a substrate produces the thing of the configuration corresponding to an array.
[0039] In this example, although a great portion of light which carried out incidence is caught by Si ball or the rod in the case of oblique incidence like incident light 81, 82, 87, and 88 and it contributes to a generation of electrical energy, a substrate part is penetrated and most light which dies (to field which is the bottom in Fig. 4 (c)) cannot be found.
[0040] On the other hand, to light with high altitude, the part is penetrated through a substrate part like incident light 83, 84, 85, and 86. That is, a component which transparency is small as a whole and is penetrated to some extent to the light of the high altitude of day ranges, for example to the sunlight of the low altitude in every morning and evening is formed.
[0041] Thus, a solar battery element with various addition functions is possible by adjusting the array consistency of Si ball or a rod suitably. Since adjustment of such an array consistency just needs to adjust the concavo-convex structure of a substrate beforehand, it can realize configuration control with difficult implementation easily and precisely, and cheaply by the approach of **.
[0042] There is nothing also until it begins the method of the array of the method of the incidence of light, a ball, or a rod besides the example described here and says that various deformation and application are possible.
[0043]
[Effect of the Invention] As explained above, since [which is depended on this invention] the start raw material was spherically cheap in a cylindrical crystal solar battery, the low price was realizable as a component. High optical confinement was realized by compound of effectiveness, such as that this first substrate has constituted the so-called texture structure by the reverse pyramid, and spherical or extensive incidence angular aperture by cylindrical Si, and the property top of a solar battery was also able to attain the well head.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] This invention is the thing about spherical or the solar battery which uses a rod-like semiconducting crystal as a main component by which adhesion support was carried out on the substrate.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Expectation is attracted as a way stage supporting the energy need in the 21st century from the description that the solar battery which uses silicon (it is hereafter described as Si) as typical material has few elements which pollute an environment compared with other power generation means in the process of its manufacture and use.
[0003] The comparatively efficient solar battery with which practical use is widely presented from the former Since the wafer (typically 350-micrometer thickness) cut down from the bulk crystal of the single crystal formed by melting raising etc. thru/or Polycrystal Si is finally comparatively used as start material through the high grade chemically-modified [various] degree from the metal class Si of a low price, the material wafer itself -- expensive -- therefore, a solar battery element -- the part -- expensive -- not becoming -- it did not obtain but had become the hindrance of spread.
[0004] On the other hand, it is Texas Instruments in order to achieve low-pricing of a solar battery element. The shrine produced the spherical crystal grain child with a diameter of a little less than 1mm. This particle was embedded at the aluminum foil with which the hole opened, and the solar battery was produced through the component chemically-modified [various] degree (refer to JP,6-13633,A; here, it is called the aluminum method).
[0005] The configuration of this aluminum method is shown in drawing 5 . It is insulating resin prepared between the aluminum foil 122 with which the aluminum foil with which 121 in drawing constitutes a p-type silicon ball, and 122 constitutes a negative electrode, and 123 constitute n mold diffusion layer, and 124 constitutes the above-mentioned negative electrode, and the aluminum foil 125 which constitutes a positive electrode. And he forms a hole in aluminum foil 122, and is trying to arrange some p-type silicon balls 121 there. Since this approach was using the cheap material as the start ingredient, the punching process to the aluminum foil of what a solar battery cheap as a result may consist of had the complicated process to which precision embeds the low and spherical p-type silicon ball 121 in a hole, and a high speed and a lot of manufacture had the fault of being unsuitable.
[0006] Moreover, some which have arranged spherical Si were between each mesh on the base material knit in the shape of a mesh as another attempt (refer to JP,9-162434,A; here, it is called a mesh method).
[0007] The configuration of this mesh method is shown in drawing 6 (a) and (b). (a) the positive electrode with which a granular Si cel and 202 consist of glass/aluminum/Ag among drawing in 201 -- a conductor and the negative electrode with which 203 consists of glass/Ag -- a conductor and the insulating support which 204 becomes from glass -- it is -- insulating support 204, forward, and a negative electrode -- a conductor 202,203 is knit in the shape of a mesh, and the granular Si cel is arranged between meshes. By this approach, in addition to cost starting production of a reticulated base material, the problem was in the homogeneity of the magnitude of a mesh, and when offering the solar battery of a low price and high-reliability, there was a problem.
[0008] Moreover, drawing 6 (b) shows cross-section structure. p mold granular silicon with which the inside 231 and 232 of drawing constitutes a granular Si cel in the (a) Fig., n mold diffusion layer, and 233 -- the (a) Fig. -- setting -- a negative electrode -- the negative electrode equivalent to a conductor 203 -- a conductor and 234 -- the (a) Fig. -- setting -- a positive electrode -- the positive electrode equivalent to a conductor 202 -- as for a conductor and 235, p mold alloying field and 236 are closure resin. and a mesh-like negative electrode -- a conductor 233 and a positive electrode -- although a conductor 234 and the insulating support 204 in the (a) Fig. are minded and he is trying to arrange and support spherical p mold granular silicon 231, there is the above-mentioned trouble.
[0009] The fault common to describing [above] the aluminum method and the mesh method had the problem that it was difficult on each base material (aluminum foil and network) to arrange the shape of a ball tidily in the consistency and array as a design.

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EFFECT OF THE INVENTION

[Effect of the Invention] As explained above, since [which is depended on this invention] the start raw material was spherically cheap in a cylindrical crystal solar battery, the low price was realizable as a component. High optical confinement was realized by compound of effectiveness, such as that this first substrate has constituted the so-called texture structure by the reverse pyramid, and spherical or extensive incidence angular aperture by cylindrical Si, and the property top of a solar battery was also able to attain the well head.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] It is cheap and a base material consists of substrates of high degree of accuracy and high-reliability, and the place which this invention was proposed in view of the above-mentioned thing, and is made into that purpose is spherical or a thing which can also specify freely the dimension of a rod-like semi-conductor, and the arrangement condition and the consistency to a substrate top and which offers that manufacture approach while offering spherical or a cylindrical crystal solar battery.

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MEANS

[Means for Solving the Problem] It has the structure arranged on the first substrate in which two or more rod-like semiconducting crystals with this spherical or invention have periodic concavo-convex structure. The first conductive layer is arranged on the periodic concavo-convex structure constituted by this first substrate. Some semiconducting crystals of the shape of spherical or a rod come to contact electrically to this first conductive layer. It considered as the configuration in contact with this first conductive layer by which spherical or the second conductive layer which these some semiconducting crystals of a different part from some rod-like semiconducting crystals contacted electrically has been arranged, and the above-mentioned purpose is attained.
[0012] moreover, spherical [above-mentioned] or an above-mentioned cylindrical crystal solar battery -- setting -- this -- the semiconducting crystal of the shape of spherical or a rod -- this -- it is characterized by making it come densely to arrange in the first substrate side.
[0013] furthermore, spherical [above-mentioned] or an above-mentioned cylindrical crystal solar battery -- setting -- this -- the semiconducting crystal of the shape of spherical or a rod -- this -- dissociate mutually in the first substrate side, and it is made to arrange, and is characterized by making it make a part of incident light penetrate.
[0014] Furthermore, the semiconducting crystal of the shape of spherical or a rod is made into a unit, within said unit, each semiconducting crystal approaches or contacts and said semiconducting crystal is characterized by said two or more things [dissociating mutually and coming to be arranged] between said units again.
[0015] Moreover, it is characterized by the thing which come to contain the second process which gives spherical or irregularity structure periodic to the first process which produces a rod-like semiconducting crystal, and the matter which constitutes this first substrate, and the third process made to arrange uniformly by making said semiconducting crystal drop into said crevice on the first substrate as the manufacture approach and for which spherical or a cylindrical crystal solar battery is manufactured.
[0016] Moreover, in the above-mentioned manufacture approach, in case this first substrate is manufactured, it is characterized by including the fourth process which forms the mold which has periodic concavo-convex predetermined structure beforehand, and the fifth process which forms this first substrate by imprinting the concavo-convex structure which this mold has.
[0017] Furthermore, in the above-mentioned manufacture approach, it is characterized by the part which constitutes the irregularity in this mold consisting of silicon.
[0018]
[Embodiment of the Invention] In short in this invention, the front face has adopted the solar-battery structure which comes to support the semiconducting crystal of the shape of a globular shape and a rod on the so-called substrate of the reverse pyramid configuration of making concave convex. Namely, the structure arranged on the first substrate with periodic concavo-convex structure in two or more spherical or rod-like semiconducting crystals is given. The first conductive layer is arranged on the periodic concavo-convex structure constituted by this first substrate. this first conductive layer -- receiving -- the above -- it is considering as spherical or the configuration which some rod-like semiconducting crystals were contacted electrically and has arranged this first conductive layer and the second conductive layer which contacted, and which contacted spherically electrically to some semiconducting crystals of a different part from some rod-like semiconducting crystals. And it enables it to acquire a desired property by setting up the configuration of concavo-convex structure, an array, and a period suitably.
[0019] That is, if it is periodic irregularity structure, the thing with the dimension of the concavo-convex structure and the dimension which agreed made to arrange easily the semiconducting crystal of the shape of spherical or a rod on this substrate is possible. If the mold made from Si is used especially, by applying

a known photolithography technique, concavo-convex period/dimension can specify arrangement condition and a consistency to a precision easily, and can offer a substrate cheaply and in large quantities by imprinting this mold structure further. By using such a substrate, spherical or the solar battery with which the cylindrical crystal has been arranged by the distribution density of arbitration of the dimension corresponding to the purpose can be offered.

[0020]

[Example 1] Drawing 1 (a) - (h) shows the 1st example of this invention. First, in the (a) Fig., one in drawing is the mold which becomes by Si, and produced the concavo-convex structure of the shape of a reverse pyramid which consisted of Si (111) sides with the known photolithography technique. The potassium hydroxide performed etching. The concavo-convex structure of mold 1 was imprinted by clear glass 2, and made this the first substrate 2.

[0021] Subsequently, as shown in the (b) Fig., in order to use it as one electrode of a solar battery on the reverse pyramid-like structure of this first substrate 2, the transparent electrode 3 was made to adhere as the 1st conductive layer, and the antireflection film 4 was made to adhere to the field (for it to become the plane of incidence of sunlight behind) of ** of the opposite side.

[0022] On the other hand, 1100 degrees C and heat-treatment of 10 hours separated into the layer 6 near the front face containing many impurities, and p form part 5 with few impurities Si crystal into which the metal class Si was spherically processed as a raw material, as shown in the (c) Fig. Diffusion process of n form was performed to p form part 5 of a spherical high grade after etching removal in the layer 6 near the front face, and it was set to spherical Si which consists of a ball with a diameter of 0.5mm which consists of an n form layer 52 and the p form section 51 as shown in the (d) Fig.

[0023] The deer was carried out and spherical Si of a large number prepared in the (d) Fig. was put on what was applied as the sign 7 showed spin-on glass (it is called Following SOG) in the (e) Fig. to the concave convex of the first substrate 2 obtained in the (b) Fig. By adjusting the magnitude of spherical Si and a reverse pyramid configuration the optimal, each spherical Si was easily settled in each pyramid part uniformly.

[0024] Next, the pressure was put on much whole spherical Si, and it was made to stick with the first substrate 2 by heating at about 180 degrees C. SOG7 changed in the process to stick and, finally the part and transparent electrode 3 of the n form layer 52 were contacted electrically.

[0025] Then, while passing through vitrification processing of SOG several 100 degrees C or more, etching processing was performed and the part of n form layer of spherical Si which does not touch SOG7 became the cross-section structure shown in the (f) Fig. The part to which the n form layer 52 was etched into and p form section exposed 61, and 62 are the electric contact parts of the n form layer 52 and a transparent electrode 3.

[0026] If etching of this layer is advanced on this structure after applying the SOG film 8 further as shown in the (g) Fig., a part of p form outcrop 61 63 which is a part with thin thickness among the SOG film 8 will be exposed.

[0027] Besides, as shown in the (h) Fig., the p electrode 9 as the second conductive layer and the high reflective film 10 are made to adhere, and a solar battery is completed. Incidence of the sunlight was carried out like 21 and 22, high optical confinement was realized by compound of effectiveness, such as the so-called texture structure by the antireflection film 4 and the reverse pyramid, and extensive incidence angular aperture by spherical Si, and the efficient solar battery was realized as a result. SOG7 which is filling between Si ball and Si balls had become a mask at the time of etching the conductive layer and electrode of Si semi-conductor like the role of Si oxidization insulator layer in Si integrated circuit (IC), and such a process serves as a technique which matured enough in IC manufacture, and it was able to apply it to securing the insulation of each interglobular space, and coincidence with the same dependability also as this invention.

[0028] By the approach by this invention, even if fluctuation of some is in the magnitude of spherical Si, there is no problem on production, and each ball functions completely as one cell. That the precision of the magnitude of a ball is loose means that the price at the time of spherical Si formation can be kept cheap.

[0029] Moreover, although a transparent electrode 3 and the p electrode 9 are common to each spherical Si and each ball constitutes the solar battery from this example in juxtaposition, it is also possible to combine a ball with a serial and to obtain the high solar battery element of power as a whole by mixing the process which performs processing which divides two electrodes suitably, and constitutes them and connects between a ball and balls suitably.

[0030]

[Example 2] Drawing 2 shows the 2nd example of this invention. Although the profile of the production process of this 2nd example was almost the same as the 1st above-mentioned example, in order to raise

the condensing nature of sunlight, while carrying out periodic convex processing as a sign 41 shows and using sunlight plane of incidence of the first substrate 2 as an antireflection film 41, in order to collect the reflected lights in Si ball effectively, as a sign 11 also showed the high reflector of the opposite side, convex processing was carried out by this example. this example -- this -- since it is made in agreement in the period of the array of a rod-like semiconducting crystal, and the period of convex processing of plane of incidence spherically as shown in drawing, the light reflected as it was effectively condensed by spherical Si and a sign 25 showed contributes similarly effectively the sunlight which carried out incidence as signs 23 and 24 showed to a return generation of electrical energy at spherical Si.

[0031] In addition, p electrode uses the transparent electrode 91. In this example, it is possible by adjusting the curvature of convex processing of an antireflection film 41 the optimal to the thickness of the first substrate 2 to draw incident light 23 and 24 in Si ball effectively. Moreover, in this example, introducing in Si ball effectively again is possible by reflecting again the light which penetrated not only the incident light 23 and 24 but the light or Si interglobular space which once penetrated the inside of Si ball by the high reflective film 11. It is possible by adjusting the curvature of convex processing of the high reflective film 11 the optimal to the thickness of a transparent electrode 91 also in this case to draw the reflected light in Si ball effectively.

[0032] In this example, the light of oblique incidence as shown with signs 23 and 24 is also incorporated by owner ** in Si ball as mentioned above. This means that it can generate electricity effectively also to the incident light toward which not only the neighborhood but every morning and evening inclined in the daytime at the time of the meridian transit of daytime. Furthermore, therefore there are many clouds like a climate climate of Japan, the effective thing is meant also when there are many components of the scattered light compared with direct light.

[0033]

[Example 3] Drawing 3 (a) - (c) shows the 3rd example of this invention. In the case of this example, it is used in order for the second substrate 20 which has concavo-convex structure not to have an electrode etc. but to make spherical Si arrange like said 1st example. In addition, the process to drawing 3 (a) is fundamentally advanced like the aforementioned explanation to (a) - (f) in drawing 1 except for the formation process of the transparent electrode 3 shown in drawing 1 . However, the measure in which the n form layer 52 and the second substrate 20 of spherical Si are not stuck firmly unlike the 1st example is taken. This is possible by applying suitable exfoliation material beforehand, for example.

[0034] Moreover, since the process to drawing 3 (b) is the same as the process to drawing 1 (h), the same sign shows the same member and detailed explanation is omitted. Then, the second substrate 20 exfoliates and a solar battery as a transparence n electrode and an antireflection film (it omits by a diagram) given and subsequently to a part of n form layer 52 shown in the (c) Fig. completes it. In the solar battery of this example, the condensing nature of sunlight 26 and 27 is high by the own lens effectiveness of Si spherical surface. In addition, in each above-mentioned example, although the thing spherical as a semiconducting crystal was explained, a cross section may use the rod-like thing which makes a round shape.

[0035]

[Example 4] Drawing 4 shows the 4th example of this invention. (a) Drawing adjusted the period of the concavo-convex structure of the third substrate 30, and the dimension so that it might become the maximum nectar restoration about the array of a ball or a rod. In making a ball or a rod arrange, concave heights are turned for the third substrate 30 and the second substrate (not shown in drawing) with the same periodic structure down from the upper part part of the (a) Fig. this -- two or more spherical or rod-like semiconducting crystals were able to be made to arrange easily the neither more nor less on the third substrate 30 by putting in the shape of sandwiches like the second substrate / ball, or the third rod / this substrate, and pushing lightly

[0036] What is necessary is just to use the third and second substrates with the concavo-convex structure of the dimension doubled with the diameter of the ball to produce, in order to realize the maximum nectar restoration. If it is made the configuration of the maximum nectar restoration as shown by drawing 4 (a), since there will be no light which penetrates between Si ball or rods, it is possible to catch sunlight more effectively and high photoelectric conversion efficiency can be attained.

[0037] Contrary to the (a) Fig., the thing of drawing 4 (b) opens clearance and arranges a ball or a rod to a non-dense. 92 are a transparent electrode and a protective coat with transparent 12 among drawing. Although a part is caught by spherical or the cylindrical semi-conductor among the sunlight which carries out incidence as signs 21 and 22 show, a part is penetrated like 28 and 29. That is, the solar battery of a see-through form so-called translucent type can be made as a whole. The rate of the transmitted light to all incident light can be set as arbitration by adjusting the arrangement consistency of a ball or a rod suitably.

[0038] (a) and (b) are the examples which performed a different array, and the thing of drawing 4 (c) consists of forms which a part with the dense array of Si ball or a rod and a **** part compound. namely, plurality -- said -- the semiconducting crystal of the shape of spherical or a rod was made into the unit, and within said unit, each semiconducting crystal approaches or contacts, and between said units, said semiconducting crystal dissociated mutually and has arranged. In addition, in this drawing, the configuration of the part of the substrate which presented periodic structure is omitted, and it cannot be overemphasized that a substrate produces the thing of the configuration corresponding to an array.
[0039] In this example, although a great portion of light which carried out incidence is caught by Si ball or the rod in the case of oblique incidence like incident light 81, 82, 87, and 88 and it contributes to a generation of electrical energy, a substrate part is penetrated and most light which dies (to field which is the bottom in Fig. 4 (c)) cannot be found.
[0040] On the other hand, to light with high altitude, the part is penetrated through a substrate part like incident light 83, 84, 85, and 86. That is, a component which transparency is small as a whole and is penetrated to some extent to the light of the high altitude of day ranges, for example to the sunlight of the low altitude in every morning and evening is formed.
[0041] Thus, a solar battery element with various addition functions is possible by adjusting the array consistency of Si ball or a rod suitably. Since adjustment of such an array consistency just needs to adjust the concavo-convex structure of a substrate beforehand, it can realize configuration control with difficult implementation easily and precisely, and cheaply by the approach of **.
[0042] There is nothing also until it begins the method of the array of the method of the incidence of light, a ball, or a rod besides the example described here and says that various deformation and application are possible.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

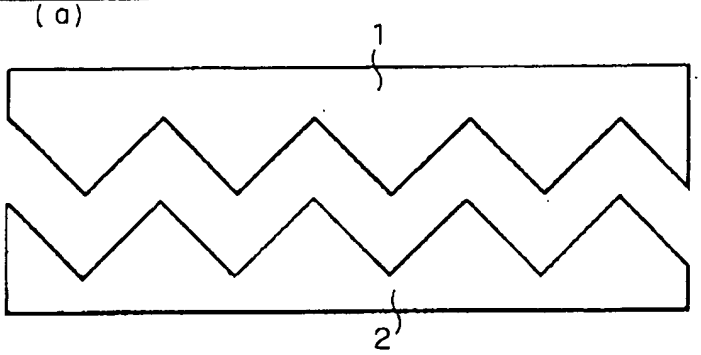
[Brief Description of the Drawings]
[Drawing 1] In the 1st example of this invention, (a) - (h) is the explanatory view showing a production process, respectively.
[Drawing 2] It is the 2nd example of this invention.
[Drawing 3] In the 3rd example of this invention, (a) - (c) is the explanatory view showing a production process, respectively.
[Drawing 4] The 4th example of this invention shows the example to which (a) carried out the array of a ball or a rod to the maximum nectar restoration, the example to which (b) arranged the ball or the rod to clearance ********, and the example to which (c) considered the array of a ball or a rod as compound with nectar and a non-dense.
[Drawing 5] The 1 conventional example called the aluminum method is shown.
[Drawing 6] The 1 conventional example which (a) calls a mesh method, and (b) show the example of cross-section structural drawing.
[Description of Notations]
1 Mold Which Becomes by Si
2 First Substrate (Clear Glass)
3 Transparent Electrode
4 41 Antireflection film
5 P Form Part of Spherical Si with Few Impurities
6 Layer near the Front Face Containing Many Impurities
7 Eight Spin-on glass SOG
9 P Electrode
10 11 Quantity reflective film
12 Transparence Protective Coat
20 Second Substrate (Example of Spherical Si Array)
21, 22, 23, 24, 25, 26, 27, 28, 29, 81, 82, 83, 84, 85, 86, 87, the example of incidence of 88 sunlight
30 Third Substrate
51 P Form Section of Spherical Si
52 N Form Layer of Spherical Si
61 Part Which N Form Layer was Etched and P Form Section Exposed
62 N Form Layer and Electric Contact Part of Transparent Electrode
63 P Form Outcrop 61 is Outcrop Part.
91 92 Transparent electrode

[Translation done.]

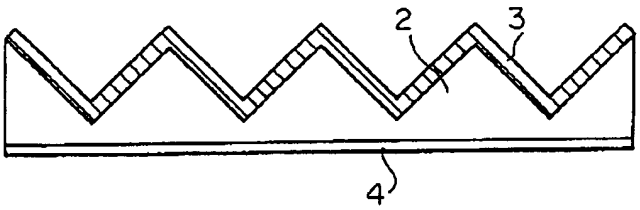
DRAWINGS

[Drawing 1]

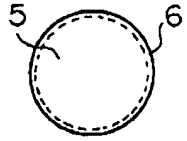
(a)



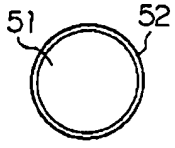
(b)



(c)

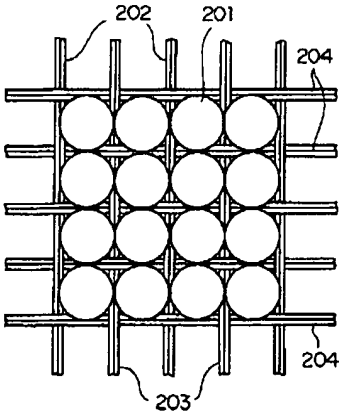


(d)



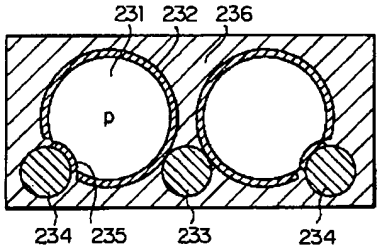
[Drawing 6]

(a)



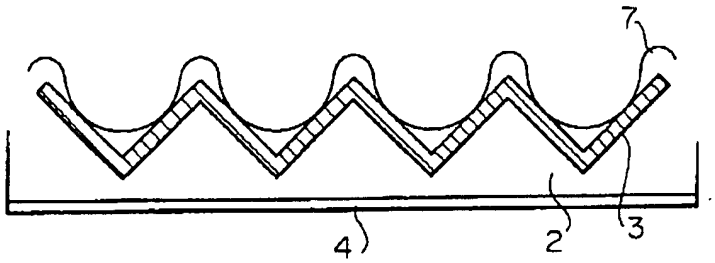
201：粒状Siセル
202：正極導体（ガラス／Al／Ag）
203：負極導体（ガラス／Ag）
204：絶縁支持体（ガラス）

(b)

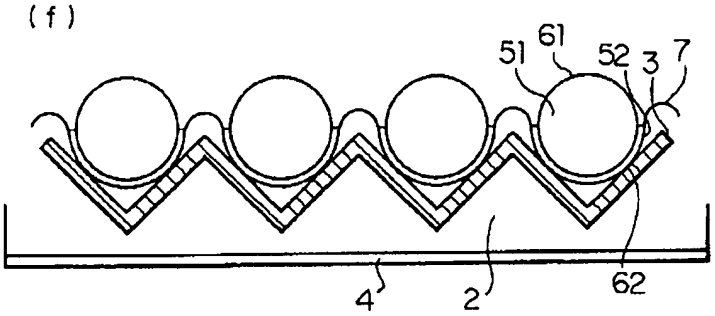


231：p型粒状シリコン
232：n型拡散層
233：負極導体
234：正極導体
235：p型合金化領域
236：封止樹脂

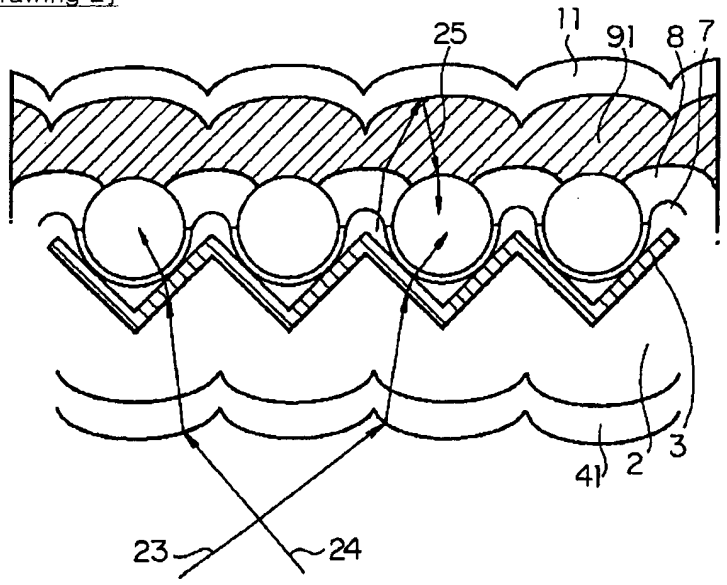
(e)



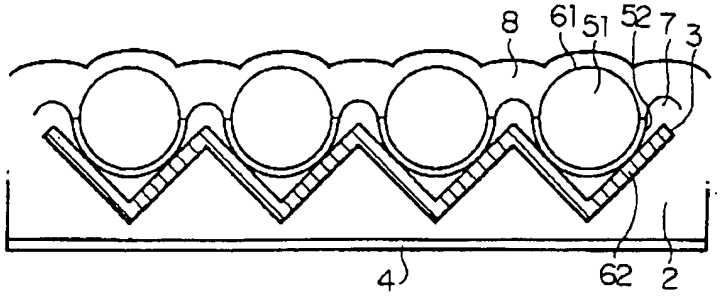
(f)



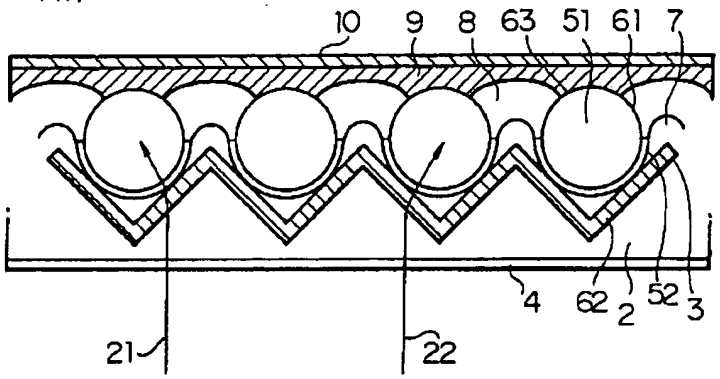
[Drawing 2]



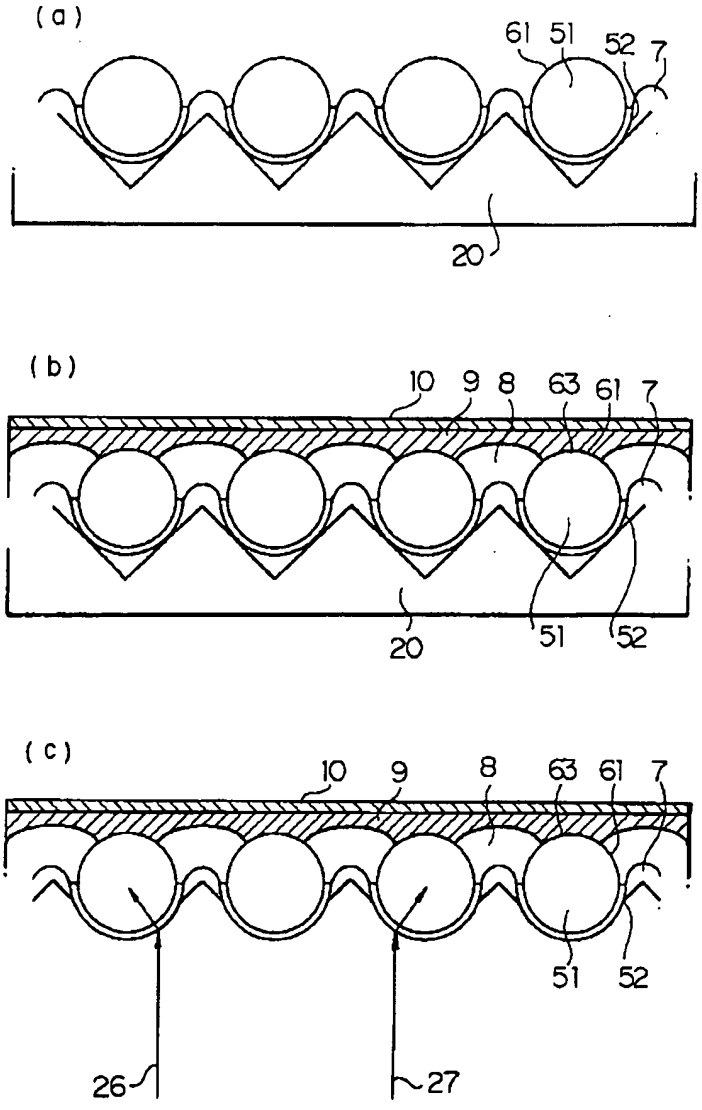
(g)



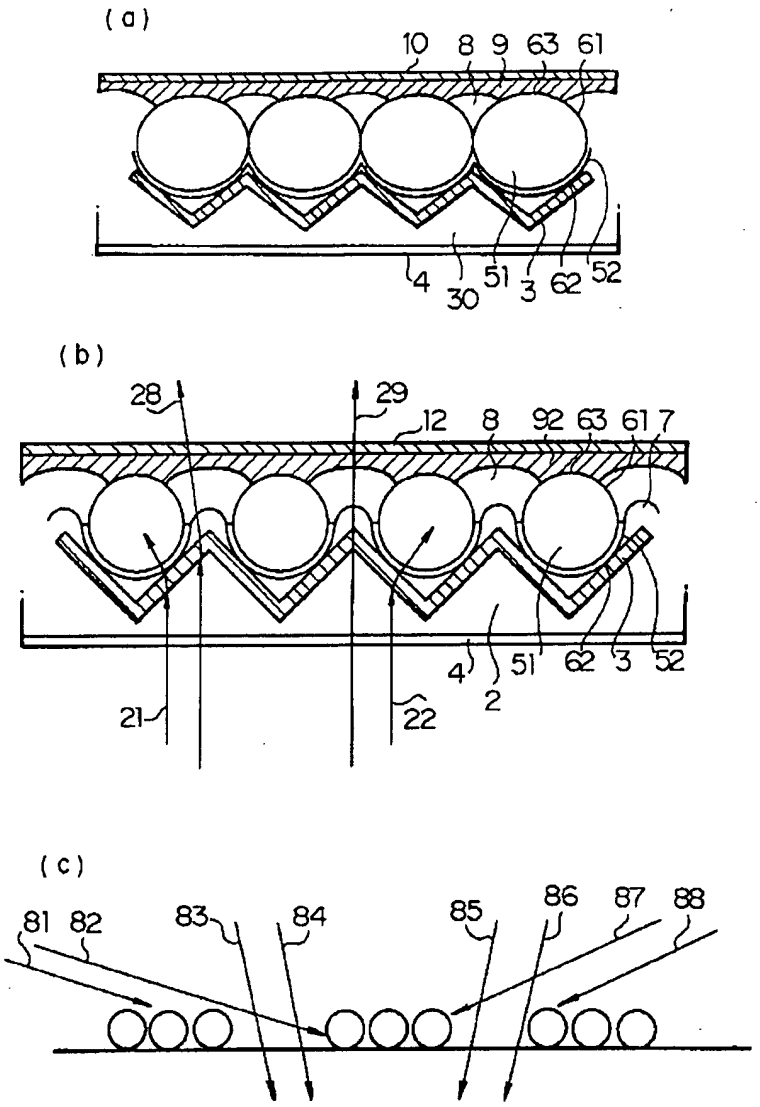
(h)



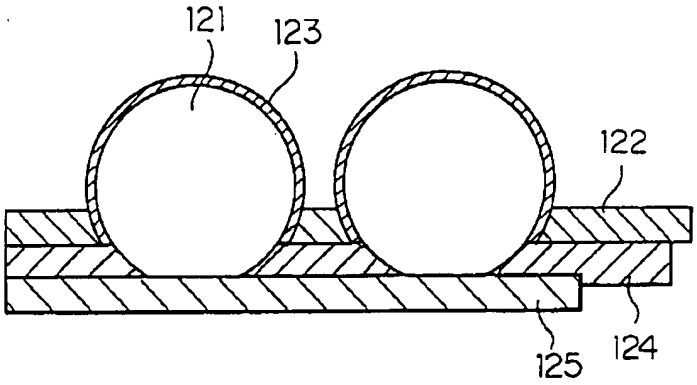
[Drawing 3]



[Drawing 4]


(a)
10 8 9 63 61
4 30 51 3 62 52
(b)
28 29 12 8 92 63 61 7
4 51 62 3 52
2
21 22
(c)
81 82 83 84 85 86 87 88

[Drawing 5]



１２１：ｐ型シリコン球
１２２：アルミ箔（負極）
１２３：ｎ型拡散層
１２４：絶縁樹脂
１２５：アルミ箔（正極）

[Translation done.]

* NOTICES *

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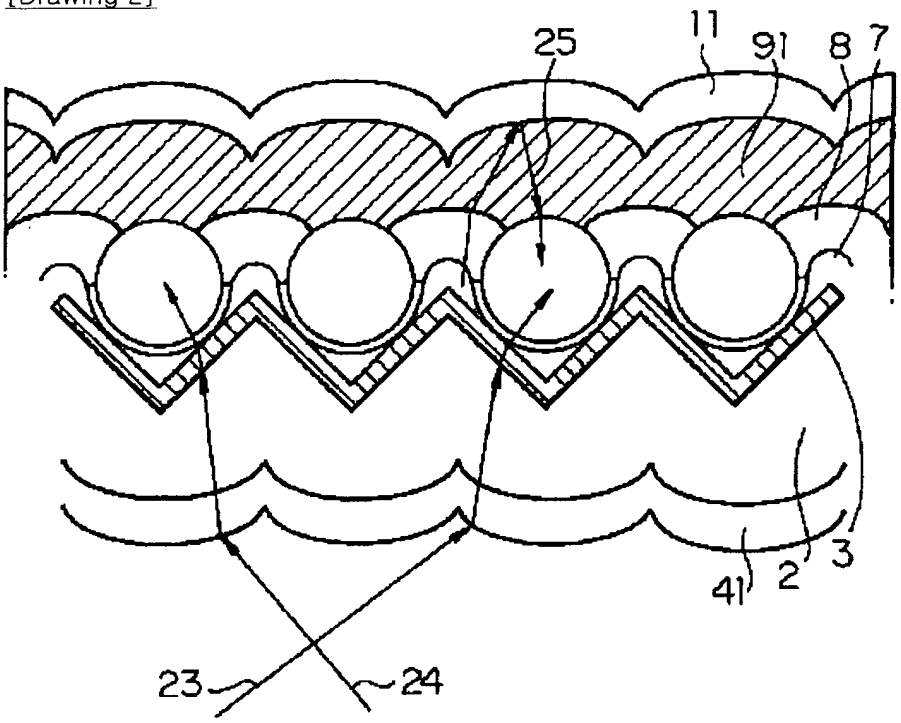
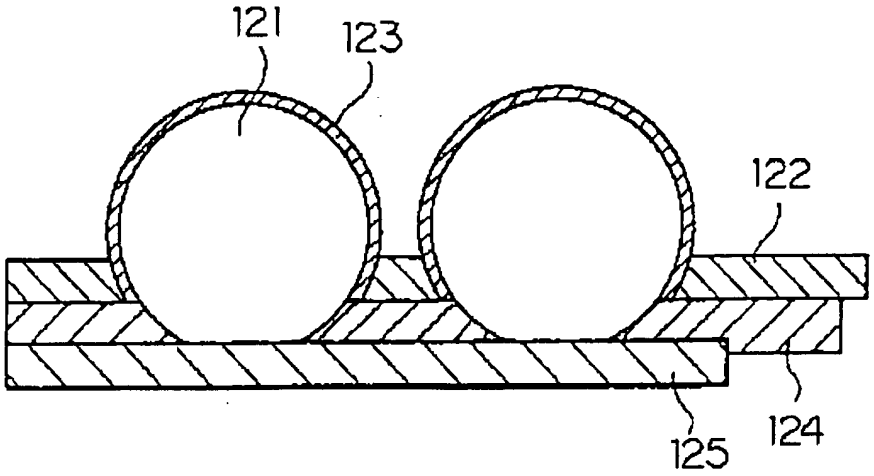
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

WRITTEN AMENDMENT

---------- [a procedure revision]
[Filing Date] June 1, Heisei 11 (1999. 6.1)
[Procedure amendment 1]
[Document to be Amended] DRAWINGS
[Item(s) to be Amended] Complete diagram
[Method of Amendment] Modification
[Proposed Amendment]
[Drawing 2]



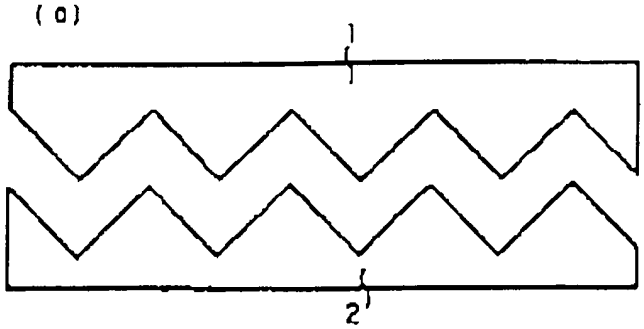
[Drawing 5]



１２１：ｐ型シリコン球
１２２：アルミ箔（負極）
１２３：ｎ型拡散層
１２４：絶縁樹脂
１２５：アルミ箔（正極）

[Drawing 1]

(a)



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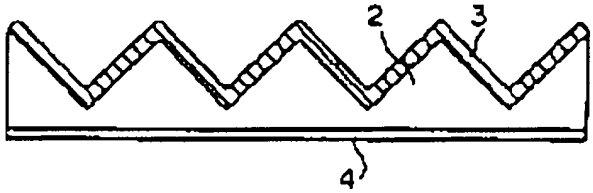
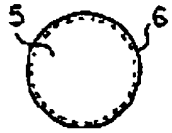


(c)



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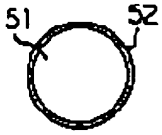
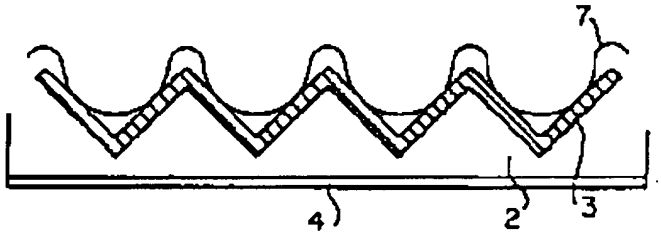
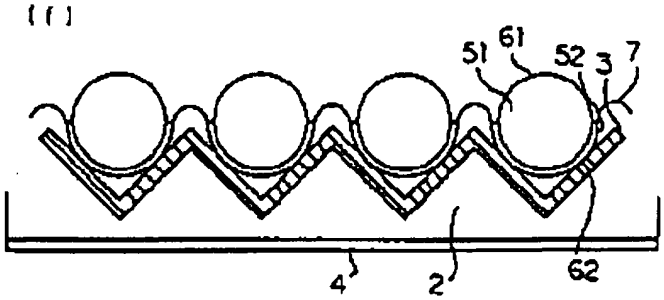


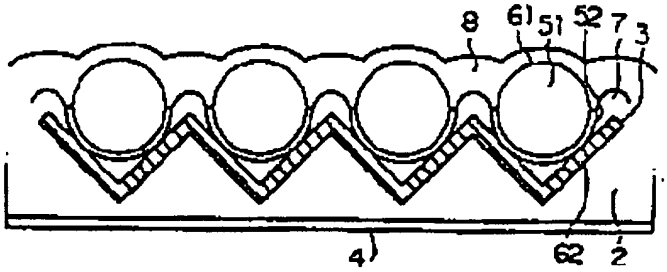
(e)



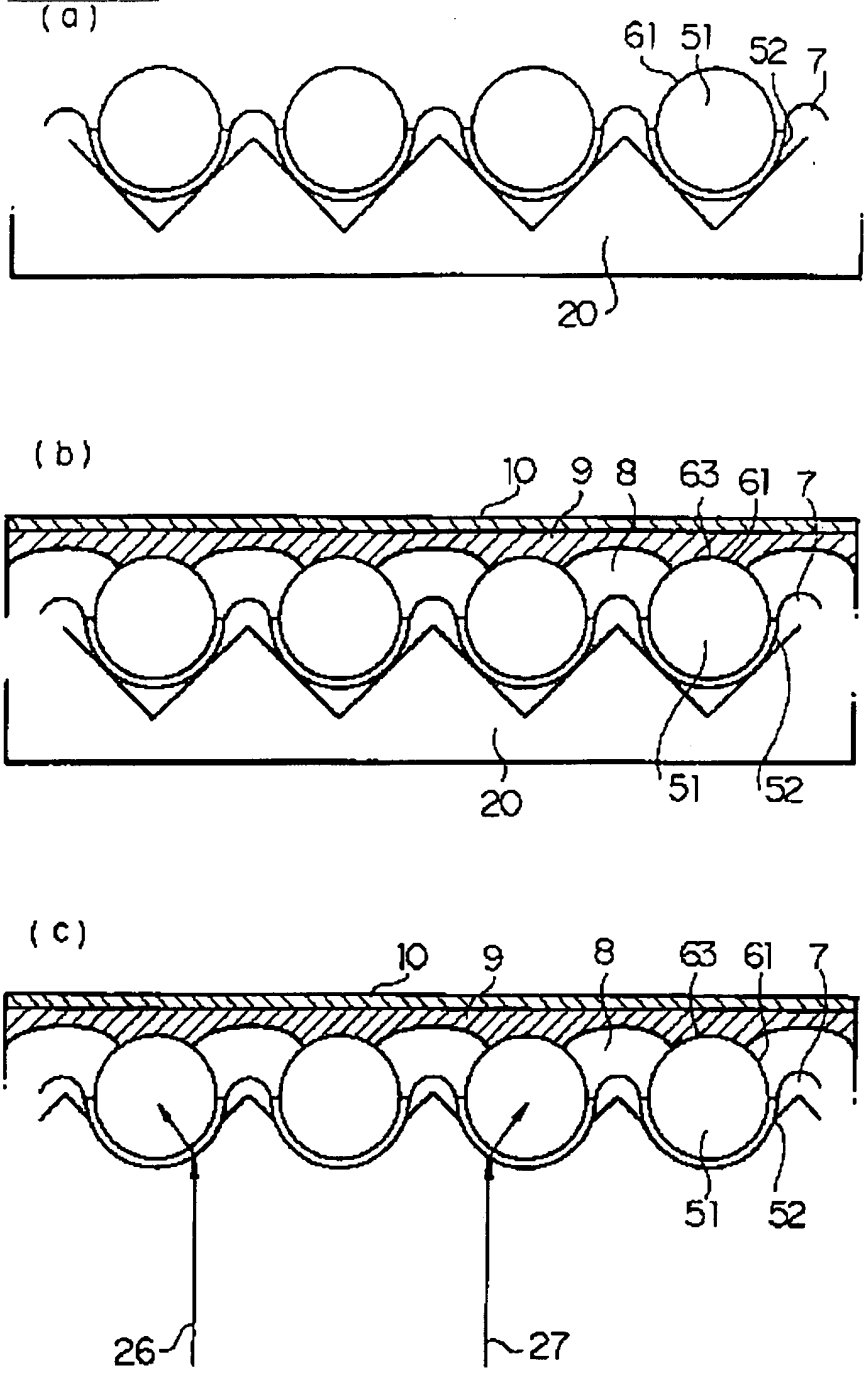
(f)



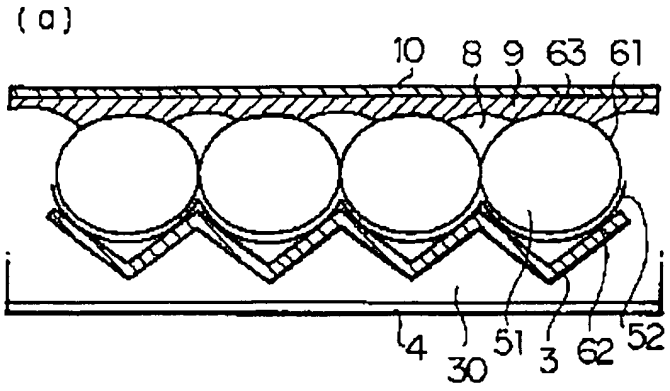
(g)

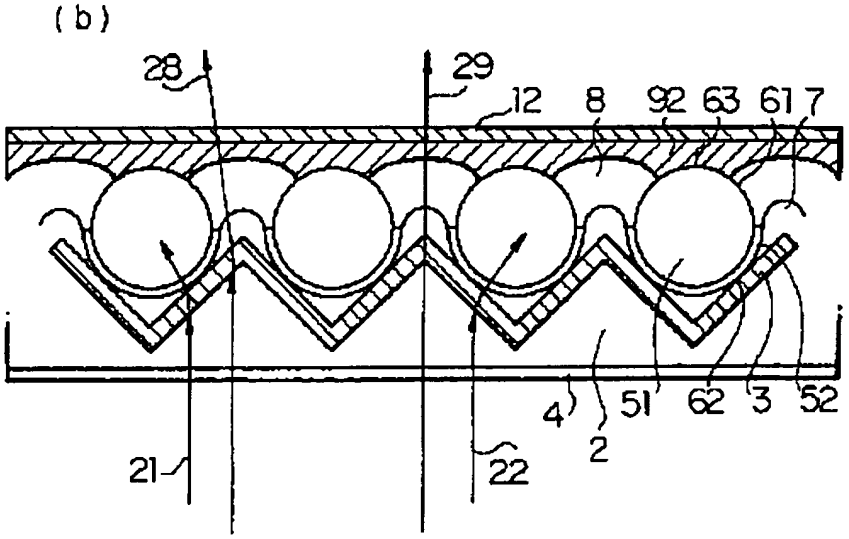


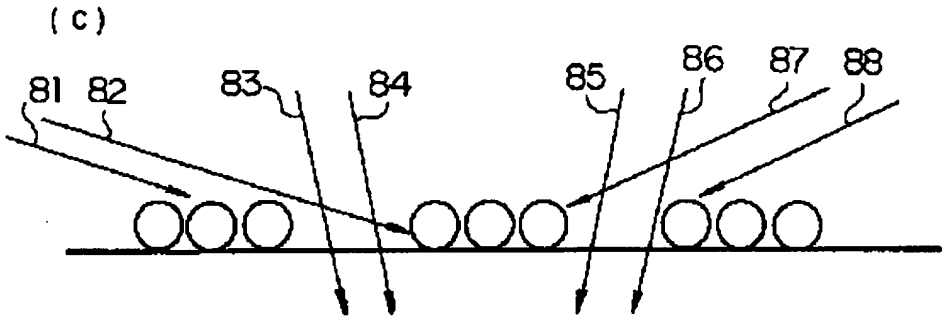
[Drawing 3]



[Drawing 4]

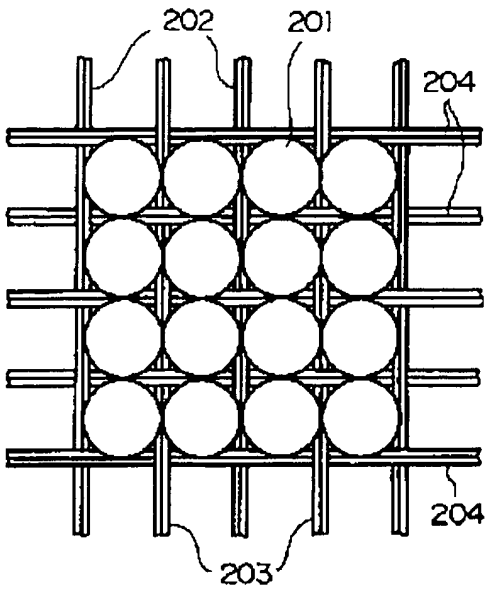

(a)
10
8
9
63
61
4
30
51
3
62
52


(b)
28
29
12
8
92
63
61
7
4
51
62
3
52
2
21
22


(c)
81
82
83
84
85
86
87
88

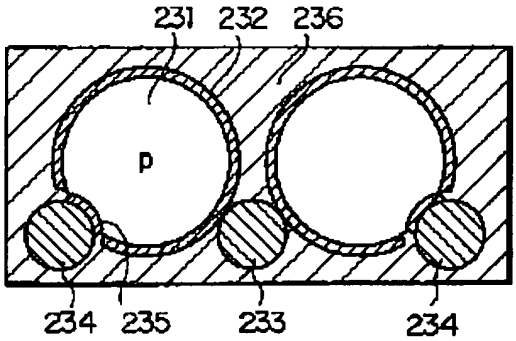
[Drawing 6]

(a)



201：粒状Ｓｉセル
202：正極導体（ガラス／Ａｌ／Ａｇ）
203：負極導体（ガラス／Ａｇ）
204：絶縁支持体（ガラス）

(b)



231：ｐ型粒状シリコン
232：ｎ型拡散層
233：負極導体
234：正極導体
235：ｐ型合金化領域
236：封止樹脂

[Translation done.]